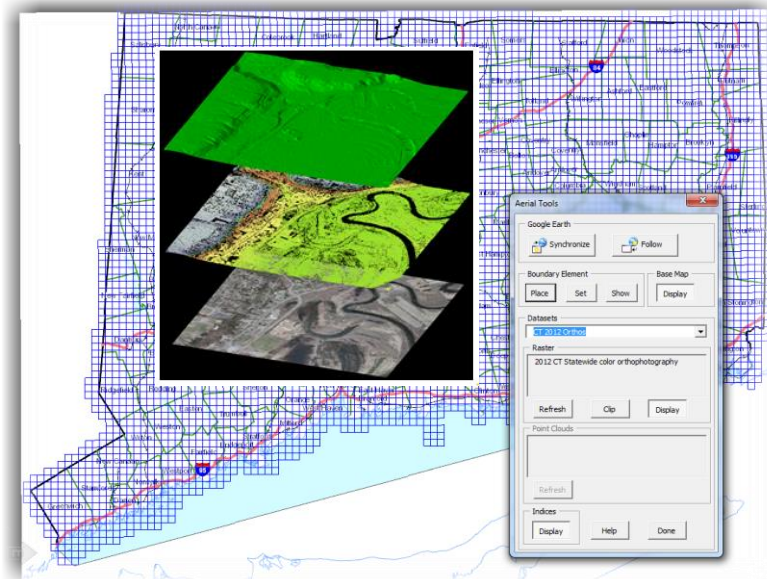**Version**

3.0

October 2016

CONNECTICUT
DEPARTMENT OF TRANSPORTATION
AEC Applications – Division of Facilities & Transit

Guide to the Earth Exploration Toolset with MicroStation V8i

Table of Contents

Section 1   **Introduction**

The CT DOT MicroStation Earth Exploration toolset was created to improve the process of attaching aerial photography and creating surfaces from LiDAR Data. The CT DOT MicroStation Earth Exploration toolset can be found on the CTDOT Utilities menu bar. The menu includes the Aerial Tools application as well as specific tools to spatially locate data and create, view and edit terrain data.

All of the tools except for "Load Aerial Tools Application" can be accessed from other areas of MicroStation; however they have been put in this menu to provide easy access to the tools required throughout the workflows in this document.

The Aerial Tools Application is a MicroStation Visual Basic Application (MVBA) specifically programmed for use with CT DOT data. It is used to locate Rasters (aerial photos) and Point Clouds (LiDAR data) and extract the needed files into MicroStation. This program also provides access to a basemap of Connecticut, so having to manually reference the DGN files such as ground files and TRU maps are no longer required. If you have existing DGN ground files you may elect to reference them in to help further define your location but it is not a requirement.
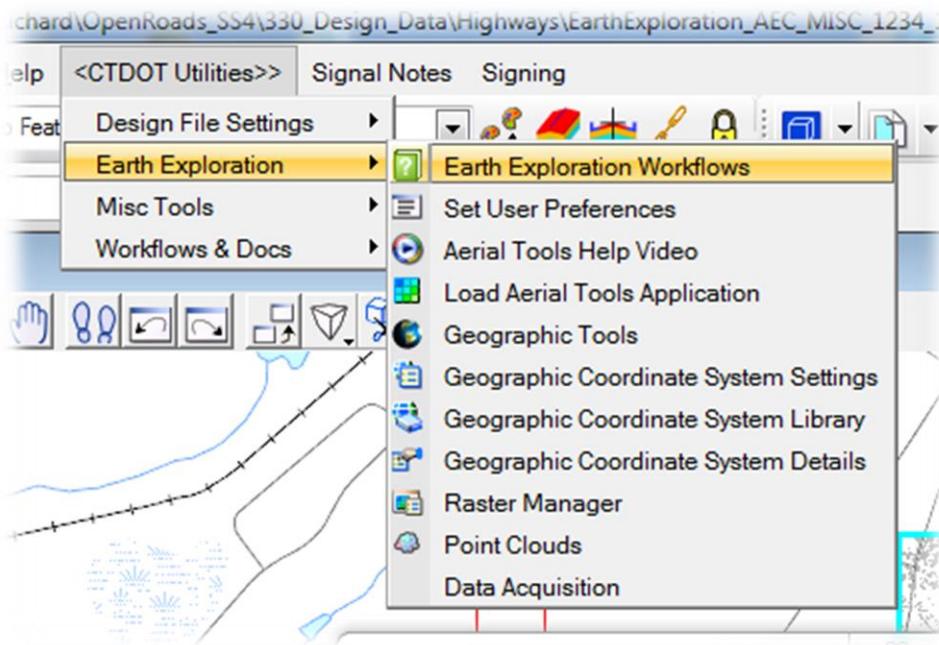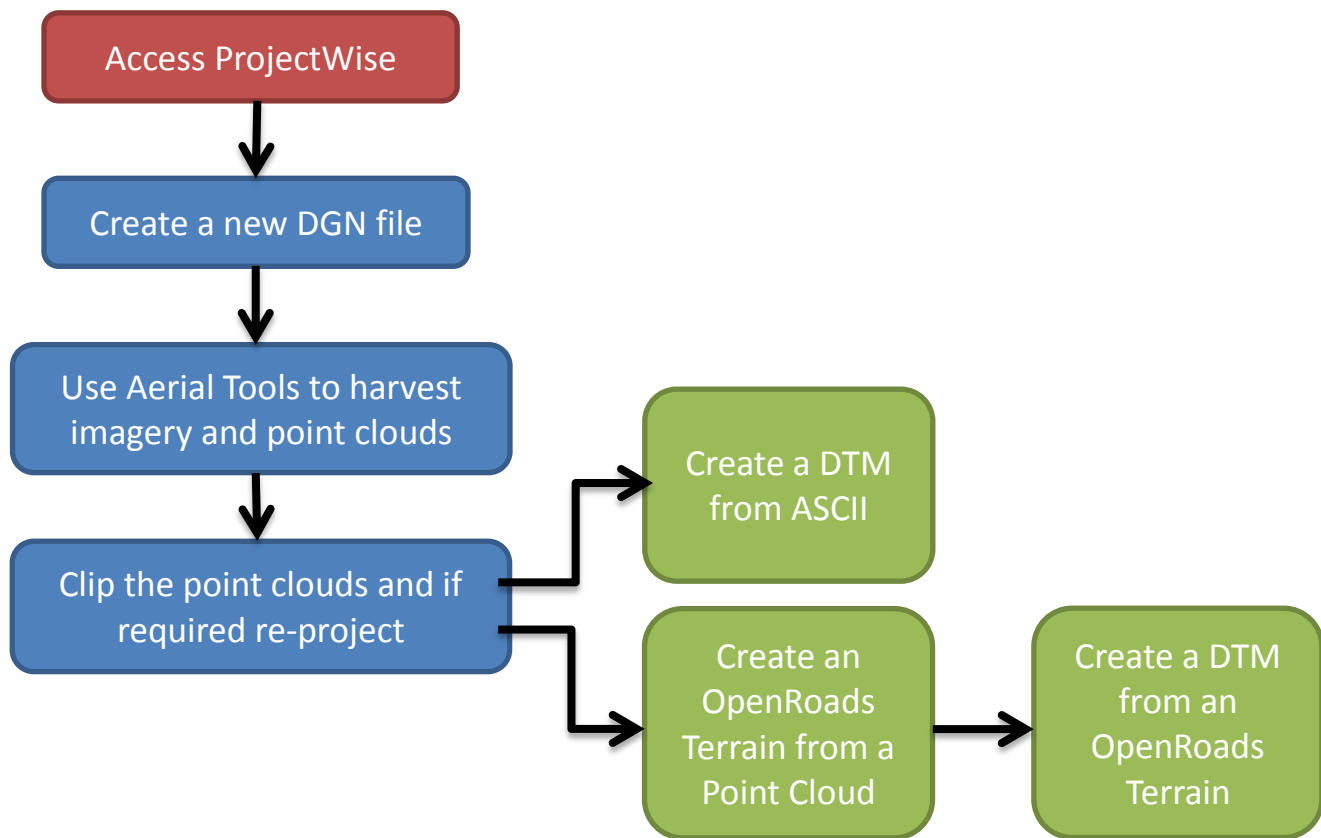

Figure 1-1 Earth Exploration Toolset

1.1 Getting Started

To use these workflows you will need to be working in ProjectWise with geo-coordinated MicroStation files. By opening a MicroStation file through ProjectWise you will have access to the latest MicroStation workspace; this workspace will connect you to the custom CT DOT Earth Exploration menu. Users will use the Earth Exploration Toolset to harvest their needed aerial photos and LiDAR data. Detailed instructions are outline in this document for the procedure to export these files to the network or your local computer. Contact Elaine Richard x3278 or John Rinaldi x3323 in AEC Applications to get started working in ProjectWise. **Prerequisites for using this workflow include basic MicroStation and InRoads knowledge including understanding InRoads surface commands.**

1.1.1 Flow Chart

```
Access ProjectWise
        ↓
Create a new DGN file
        ↓
Use Aerial Tools to harvest
imagery and point clouds
        ↓
Clip the point clouds and if    →    Create a DTM
required re-project                   from ASCII

                                →    Create an              →    Create a DTM
                                     OpenRoads                    from an
                                     Terrain from a               OpenRoads
                                     Point Cloud                   Terrain
```

1.1.2 ProjectWise Set up

Follow Chapter 1, steps 1 to 5 in the OpenRoads Manual. The link is provided below.
http://www.ct.gov/dot/lib/dot/documents/aec/cad_pw_selectseries/ctdot_openroads_manual_for_designers.pdf

1.1.3 Project Start Up

Follow Chapter 2, steps 1 to 5 in the OpenRoads Manual. The link is provided below.
http://www.ct.gov/dot/lib/dot/documents/aec/cad_pw_selectseries/ctdot_openroads_manual_for_designers.pdf

*When you get to step 3 #7, use the **3D_OpenRoads_DesignSeed_83.dgn** seed file to create your new file

1.1.4 Design File Settings

1. Your MicroStation file will now be opened. On the MicroStation main menu select **CTDOT Utilities > Earth Exploration > Set User Preferences**. **Select the Georeference** Tab. Verify the settings as shown below and select the **OK** button.
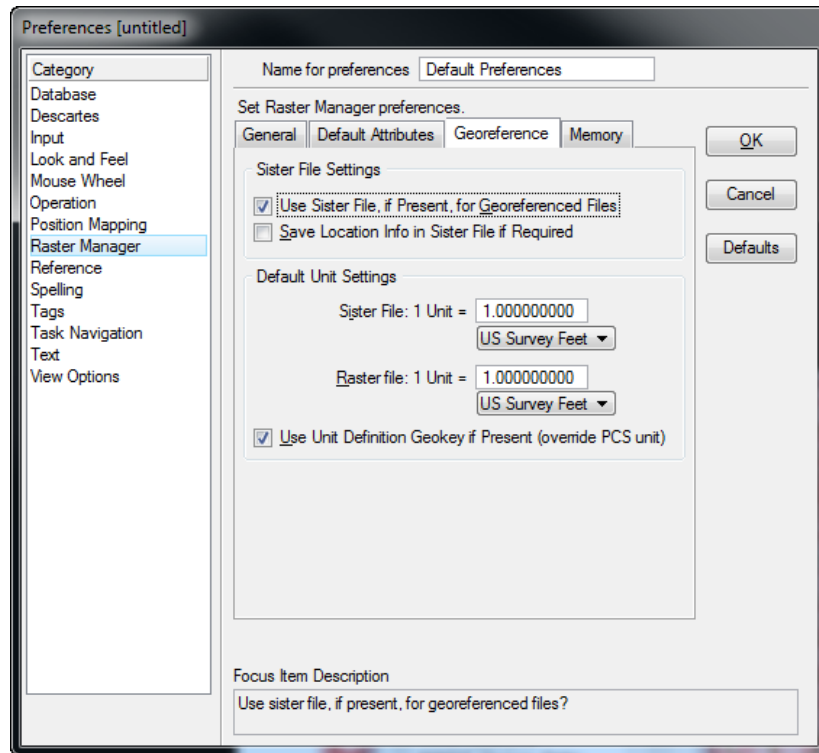

Figure 1-2 MicroStation Preferences Dialog Box

2. On the main MicroStation menu bar select **CTDOT Utilities > Earth Exploration > Geographic Coordinate System Settings**. Change Reproject Elevations to **Yes** on both tabs shown below.
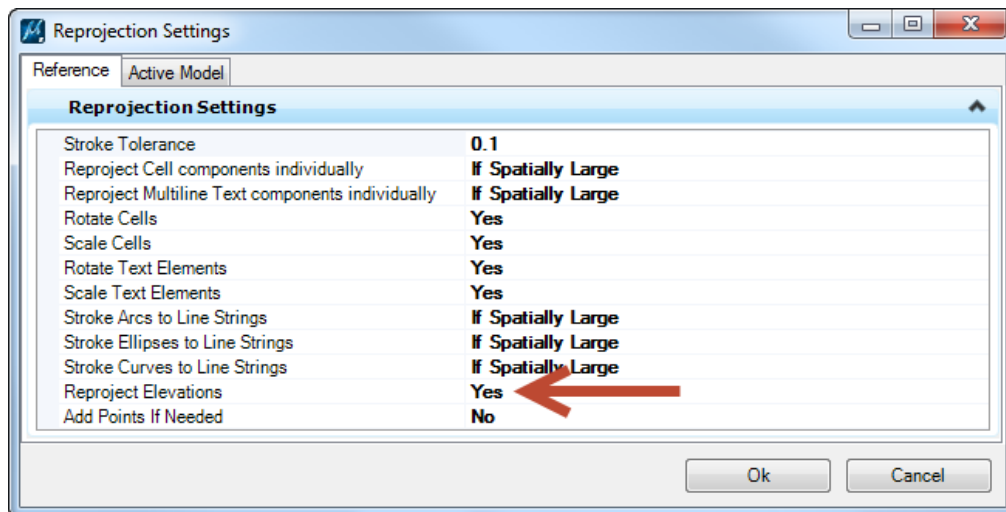

Figure 1-3 MicroStation Geographic Coordinate Reprojection Settings Dialog Box

4. On the MicroStation main menu select **File> Save Settings**.

1.2   Referencing

At this point you may opt to reference in other MicroStation files to define your area of need. Keep in mind this step is not necessarily required because a detailed map of the state of Connecticut will automatically get attached later in this workflow. If you do decide to reference you may encounter one of the scenarios listed below, so it is important to know what types of files you will be attaching. You may need to open each file and make note of the Working Units and Geographic Coordinate System Properties. MicroStation survey ground files created for or at The Connecticut DOT lists the Coordinate System in the title block.

Check the working units of each file you will be referencing. Open each file individually and select **Settings > Design File** and click on **Working Units.**

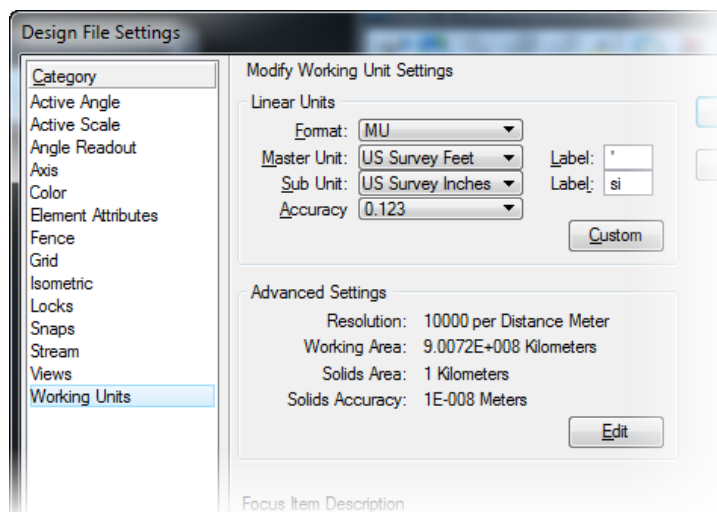If the Working Units list **US_Survey_Feet** proceed to Option 1

Figure 1-4 MicroStation Standard Unit Design File Setting

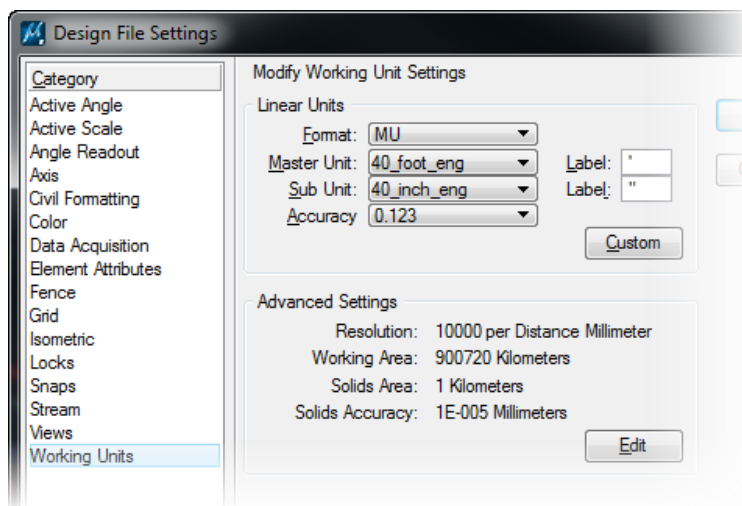If the Working Units list **40_foot_eng, 20_foot_eng, …** proceed to Option 2

Figure 1-5 MicroStation Custom Unit Design File Setting

Option 1 - Attaching a Standard Unit file

Check if the file has a MicroStation Geographic Coordinate System set. Select **Tools > Geographic > Select Geographic Coordinate System**.

Attaching a file that has a MicroStation NAD 83 Geographic Coordinate System (GCS) - This file will reference in the proper location with no adjustment required
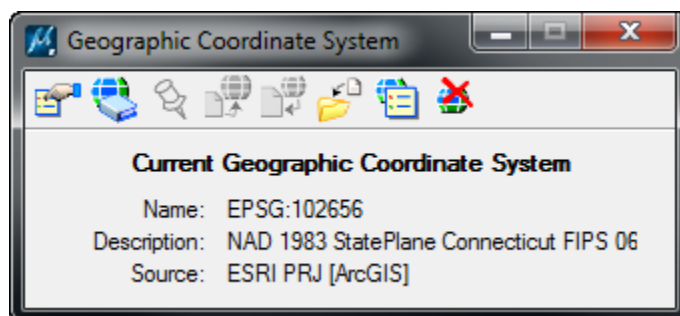

Figure 1-6 Standard Units NAD 83

Attaching a file that has a MicroStation NAD 27 Geographic Coordinate System (GCS) - When the Reference Attachment Settings dialog appears select "Geographic – Reprojected" for the Orientation and select the **OK** button.
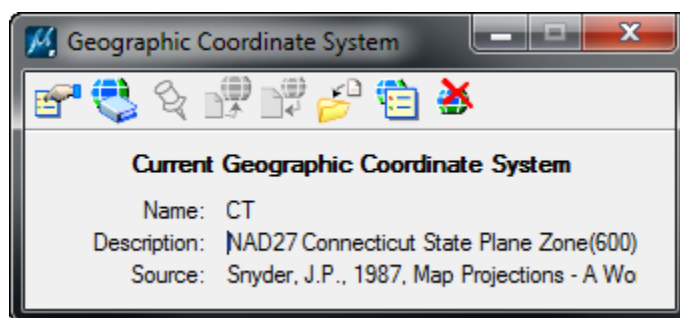

Figure 1-7 Standard Units NAD 27

Option 2 – Attaching a Custom Unit file

Attaching a custom unit based file that uses NAD 83 coordinates and lacks a GCS. When the Reference Attachment Settings dialog appears select "Coincident – World," then select the **OK** button. In the References dialog box change the scale to be one to one.
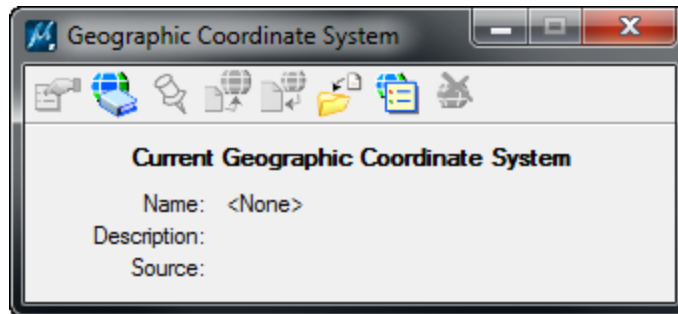
Attaching a custom unit based file that uses NAD 27 coordinates and lacks a GCS. If you encounter this scenario there are several more steps to follow.

A. Open the ProjectWise NAD 83 file created in Section 1.4 and temporarily change the Coordinate System to NAD 27

B. Select **CTDOT Utilities > Earth Exploration > Geographic Coordinate System Library**. Browse to the following folder **Projected (northing, easting…)\North America|United Stated of America\Connecticut**, select **CT – NAD27 Connecticut State Plane Zone(600), US Foot** and select **OK**.

C. On the Geographic Coordinate System Changed dialog box select **Reproject the Data to the new Geographic Coordinate System** and select **OK**.

D. Now go ahead and reference the file in. When the Attachment Settings dialog appears select "Coincident – World," then select the **OK** button. In the References dialog box change the scale to be one to one.

E. Use MicroStation tools to place a shape around your area of interest.

F. Change the Coordinate System back to NAD 83, select **CTDOT Utilities > Earth Exploration > Geographic Coordinate System Library**. Choose **HPGN/HARN Connecticut State Plane Zor** and select **OK**.

G. On the Geographic Coordinate System Changed dialog box select **Reproject the Data to the new Geographic Coordinate System** and select **OK**.

H. You will notice that the shape will be reprojected and the reference file will not. This is ok for now just leave the file as is and move on to the next step.

Section 2   The Aerial Tools Application

The Aerial Tools Application specifically programmed for use with CT DOT data. It is used to locate rasters (aerial photos) and Point Clouds (LiDAR data) and extract the needed files into MicroStation.

2.1   Accessing the Aerial Tools Application

To start using the Aerial Tools Application go to the MicroStation Main menu and select **CTDOT Utilities > Earth Exploration > Load Aerial Tools Application**. A help video can be accessed by clicking on **Aerial Tools Help Video** above the load application.
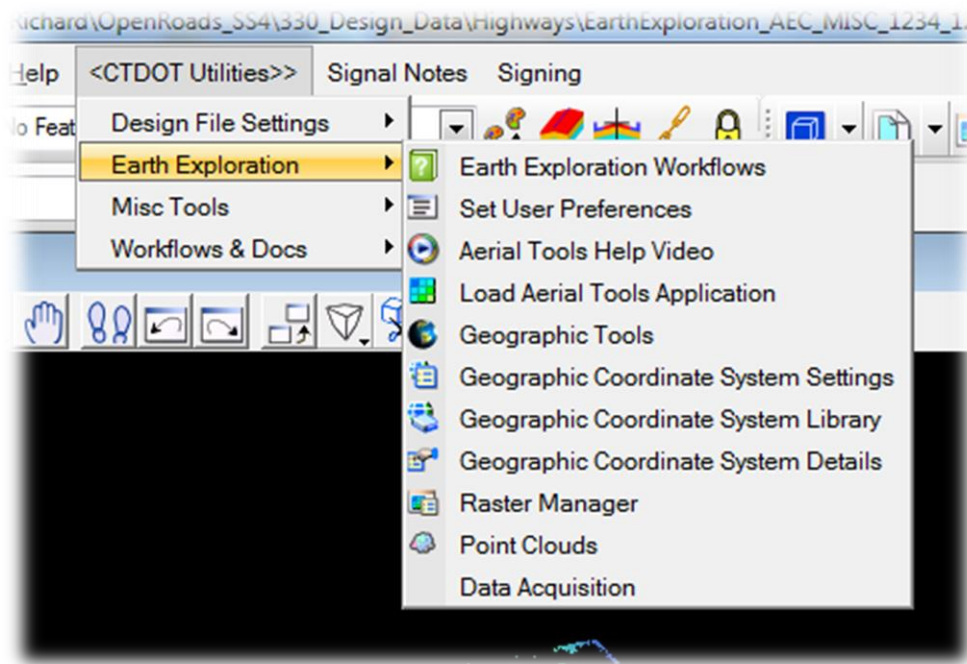
Figure 2-1 MicroStation CTDOT Utilities Menu Drop Down

2.2   Using the Aerial Tools Application

Use the Aerial Tools Application to bring in Aerials Photos and Point Clouds. Here are the basic steps, for detailed instruction watch the help Video mentioned on the previous page.

1. If you don't already have a shape placed for the area of interest click the **Place** button and the MicroStation Place Shape command will load. Place a shape around the area you would like data to appear. Using MicroStation Element Section add the shape to your selection set.

2. Click the **Set** button and yes if it asks you **select last shape placed**.

3. Click the **Refresh** button in Raster and/or Point Clouds area. It may take a few minutes to update if you are loading several files at once.

4. After hitting the **Refresh** button in the Point Clouds section an Attach Point Cloud Reference File Dialog box will appear. Go ahead and click the **Cancel** button for each Point Cloud getting attached, work is being processed behind the scenes so this dialog box is not needed.

5. Click **Done** on the Aerial Tools Dialog Box and the application will close.
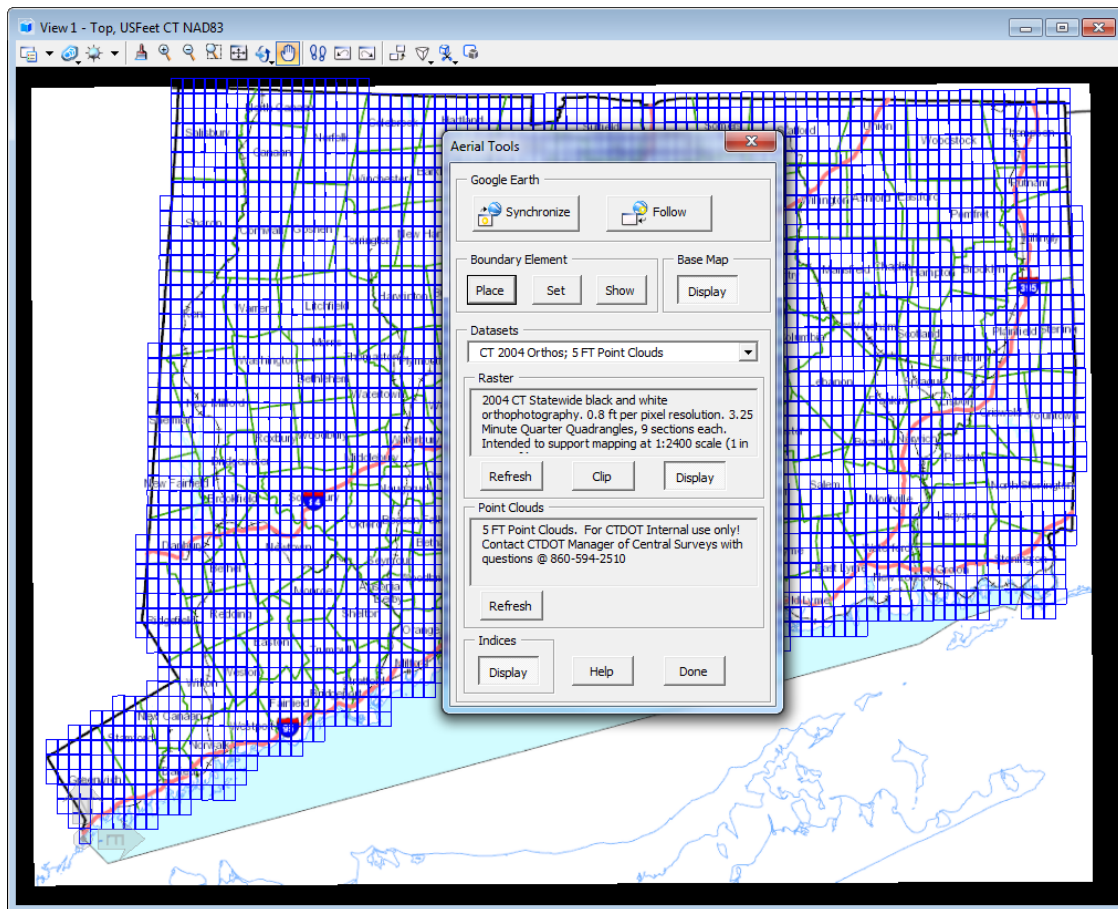

Figure 2-2 MicroStation View with Aerial Tools Dialog Box with Connecticut Background Map

Section 3 **Point Clouds**

A point cloud is a data file which can include a large number of points on the surface of an object. A point cloud is a set of vertices in a 3D coordinate system and these vertices are defined the by X, Y and Z coordinates. Point clouds are usually created by 3D scanners. These devices measure a large number of points on the surface of an object and output a point cloud as a data file. The point cloud represents the visible surface of the object that has been scanned or digitized. Point clouds are used for many purposes, especially to confirm measurements between the DGN model and the real world.
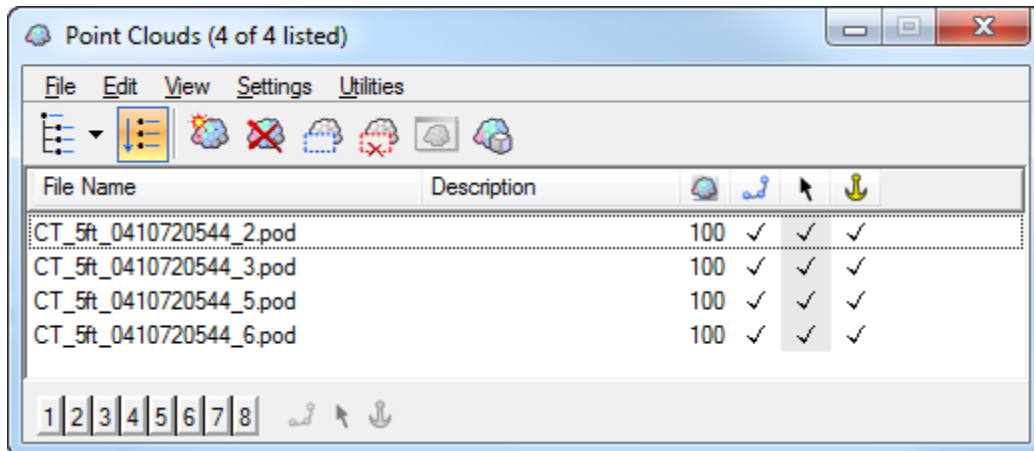
Figure 3-1 MicroStation Point Cloud Dialog Box

3.1 Point Cloud Display

1. Select the **View Attributes** icon on your View window.
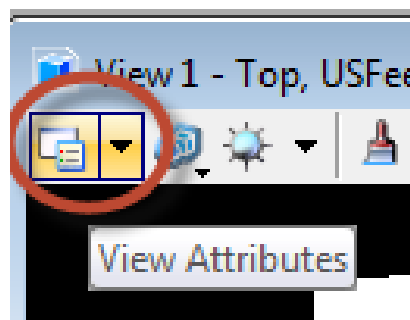
Figure 3-2 MicroStation View Attributes Button

2. For Point Cloud Presentation select **Elevation**.
3. To change the display click on the Magnifying Icon under Point Cloud Presentation. Select the desired look under Depth and Colorization and click Save Settings.
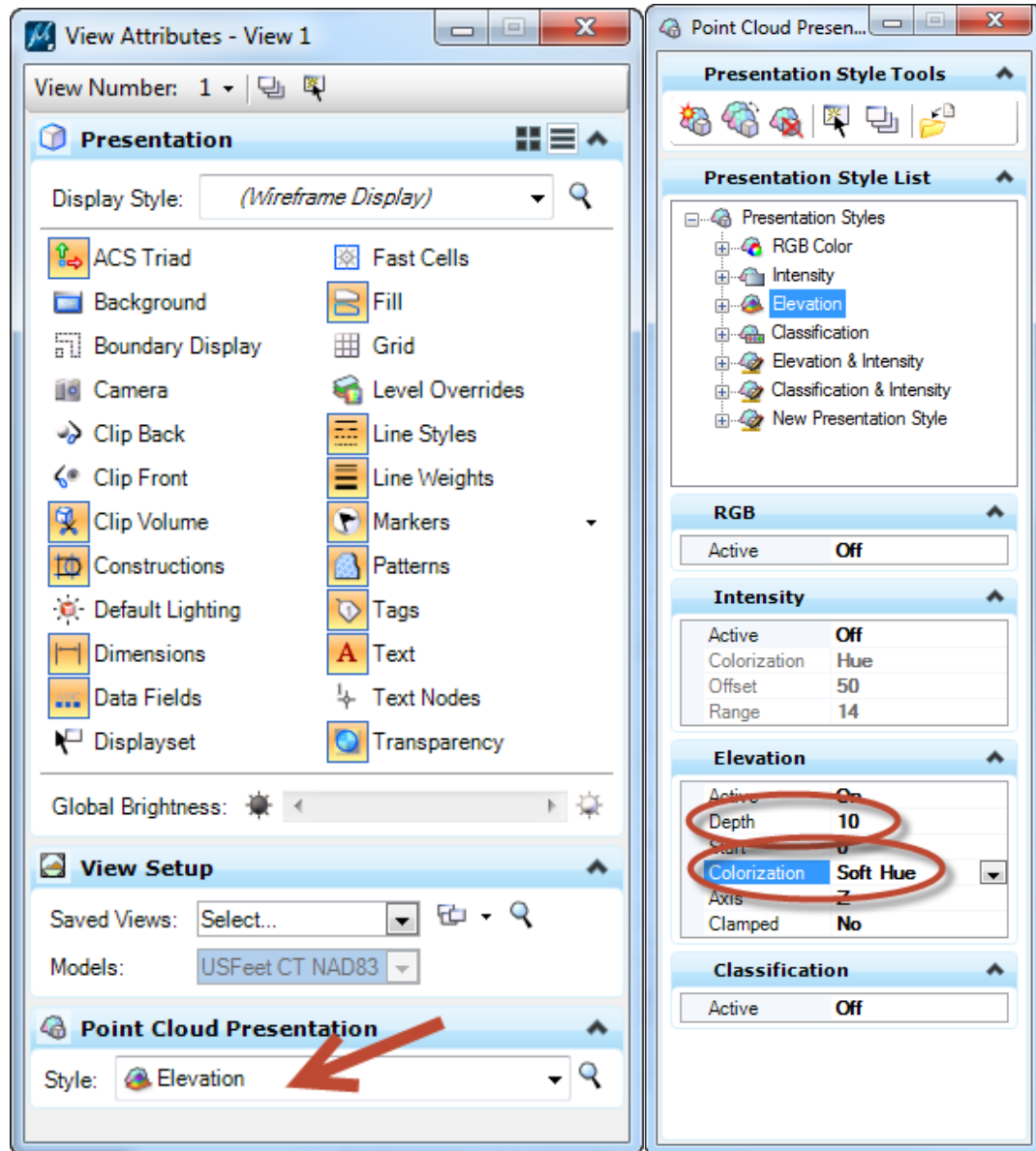

Figure 3-3 MicroStation View Attributes Dialog Box and Point Cloud Presentation Dialog Box

3.2   Using Point Clouds

The Point Clouds tools allow you to import, control, visualize and manipulate point cloud images. You can import a point cloud into a DGN and use it as a visual reference. The Point Cloud dialog (File > Point Clouds), along with the Point Cloud toolbox (Tools > Point Cloud), lets you control all aspects of attaching and manipulating point cloud image files. A point cloud is treated as any standard element and can be part of a model or level. MicroStation Point Clouds are POD files, this format allows you to work with huge point clouds at an great performance.

To	Select in the Point Cloud toolbox
Open the Point Clouds dialog, which is used to control the display of the point clouds.	Open Point Clouds Dialog
Opens the Open dialog, which allows you to attach a point cloud.	Attach Point Cloud
Detach a point cloud.	Detach Point Cloud
Clip a point cloud.	Clip Point Cloud
Delete a clip from a point cloud.	Delete Clip from Point Cloud
Open the Point Cloud Presentation dialog.	Point Cloud Presentation

You can open multiple point cloud files simultaneously. Also, you can batch convert multiple point clouds files either to one POD file, convert the data to AACII format or create a terrain model.

3.3 Creating a clipped Point Cloud

Use the Clip Tool to clip out the un-needed areas of the point clouds. This will need to be done so when the surface gets created in Section 5 you will have manageable size data. There is a limit, please don't try to get a surface from point clouds for the entire state of Connecticut, your computer and the software will surely lock up.

1. Select **Edit > Clip** our use the Icon, in the Clip Point Cloud Dialog box select the placement method, use shape or block.
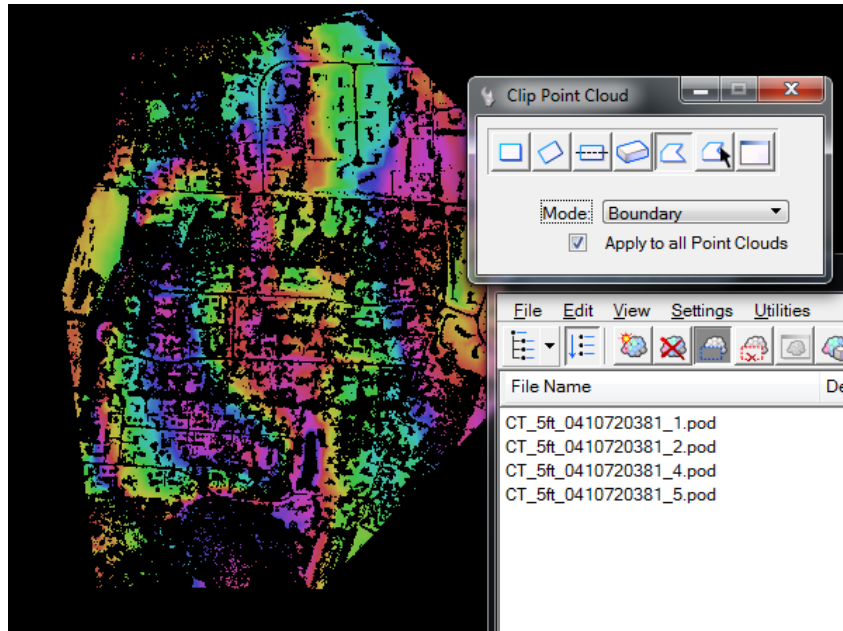

Figure 3-4 Clipping a Point Cloud

2. Highlight all the point clouds and Select **File > Export**. Change the Region filter to **Clip** and select **OK**.
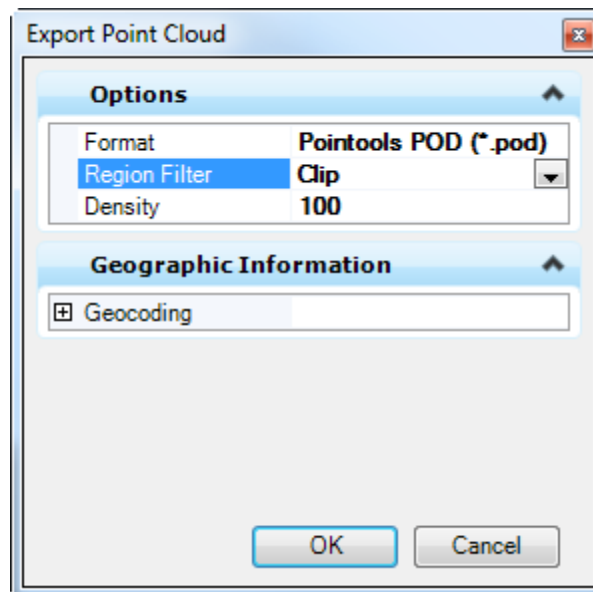

Figure 3-5 Exporting a Point Cloud

3. Select **No Wizard,** when the next box appears select your project folder and rename the clipped POD file. Click **Save**.
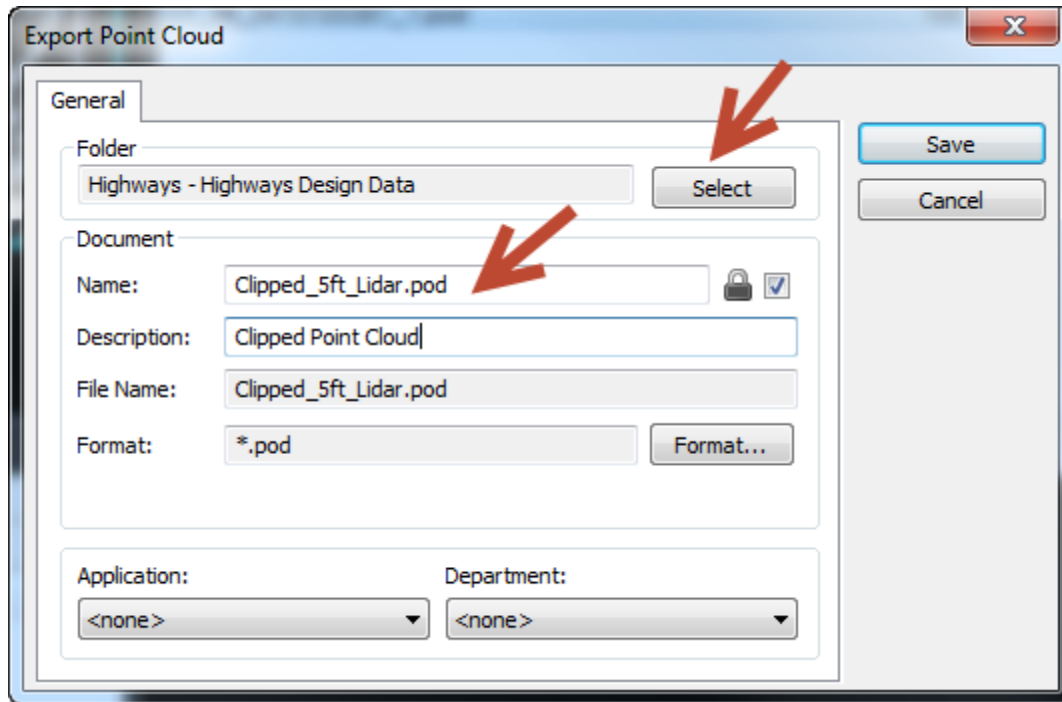

Figure 3-6 Saving an Exported Point Cloud

4. In the Point Cloud dialog box attach the new clipped POD file and detach all the others. This will be the file you will re-project and convert to a surface in the next two chapters

Section 4   Re-Projecting Data

At this point you must have the needed aerial photos and /or point clouds attached. You are currently working in the NAD 83 coordinate system and will follow this workflow if you need to repoject these files to a different system. Most needed reprojections will be English NAD 83 – NAVD 88 to English NAD 27 to NAVD 29. But in some cases the English NAD 83 – NAVD 29, English NAD 27 – NAVD 88 and metric reprojections may be needed.

4.1   Convert to Metric

If you need to work in metric you will need to change your working units **select Settings > Design File**. Click on **Working Units** and change as shown in the figure below. If you do not need to change units skip to step 2.
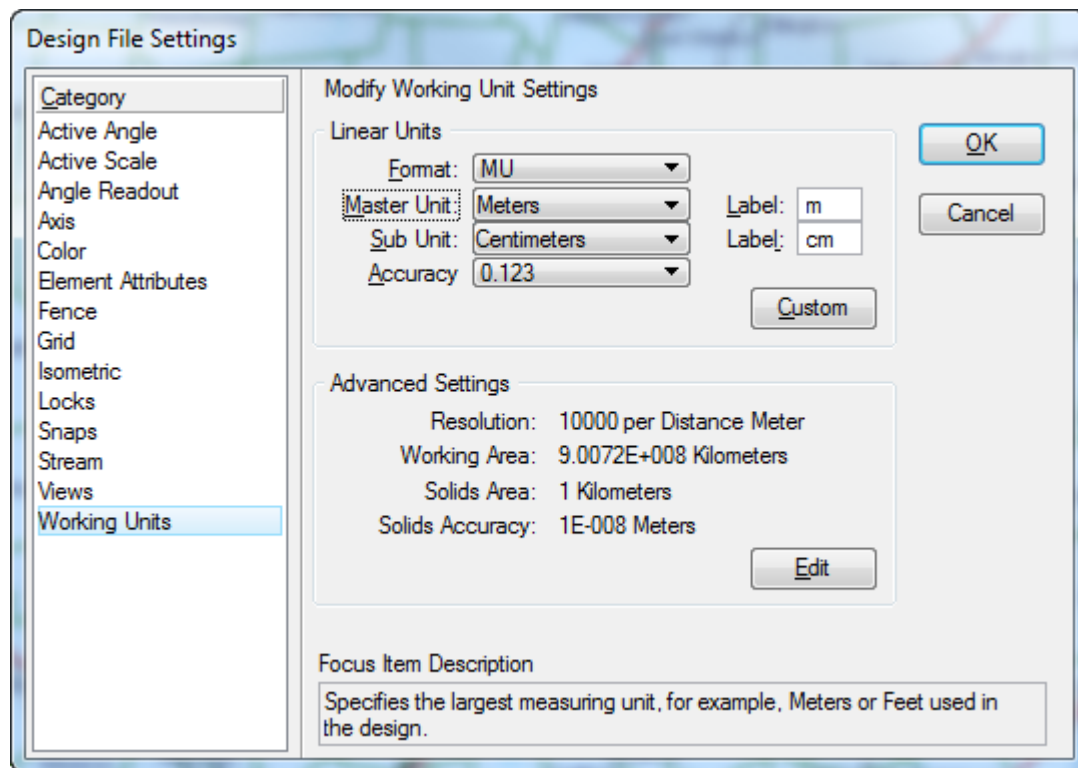

Figure 4-1 MicroStation Design File Settings Dialog Box

4.2 Horizontal Re-projection

1. To change the Coordinate System, select **CTDOT Utilities > Earth Exploration > Geographic Coordinate System Library.** Browse to the needed system and select **OK.** For NAD 83 English select: **EPSG: 102256- NAD 1983 HARN StatePlane Connecticut FIPS 0600**

   For NAD 83 Metric select: **CTHP - HARN (HPGN) Connecticut State Plane Zone, Meter**

   For NAD 27 English and Metric select: **CT- NAD27 Connecticut State Plane Zone (600), US Foot**
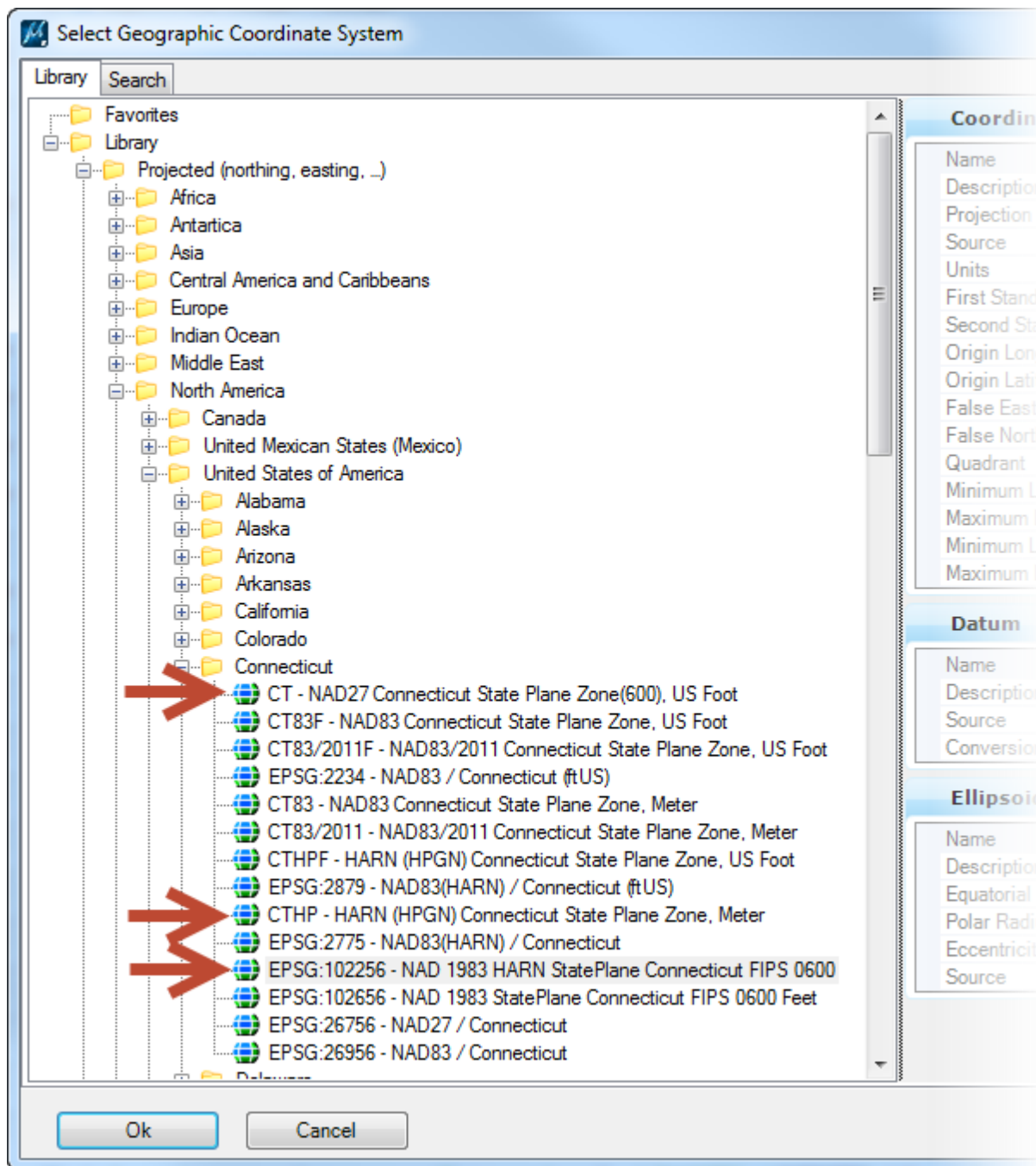

Figure 4-2 Geographic Coordinate System Library

2. On the Geographic Coordinate System Changed dialog box select **Reproject the Data to the new Geographic Coordinate System** and select **OK**.
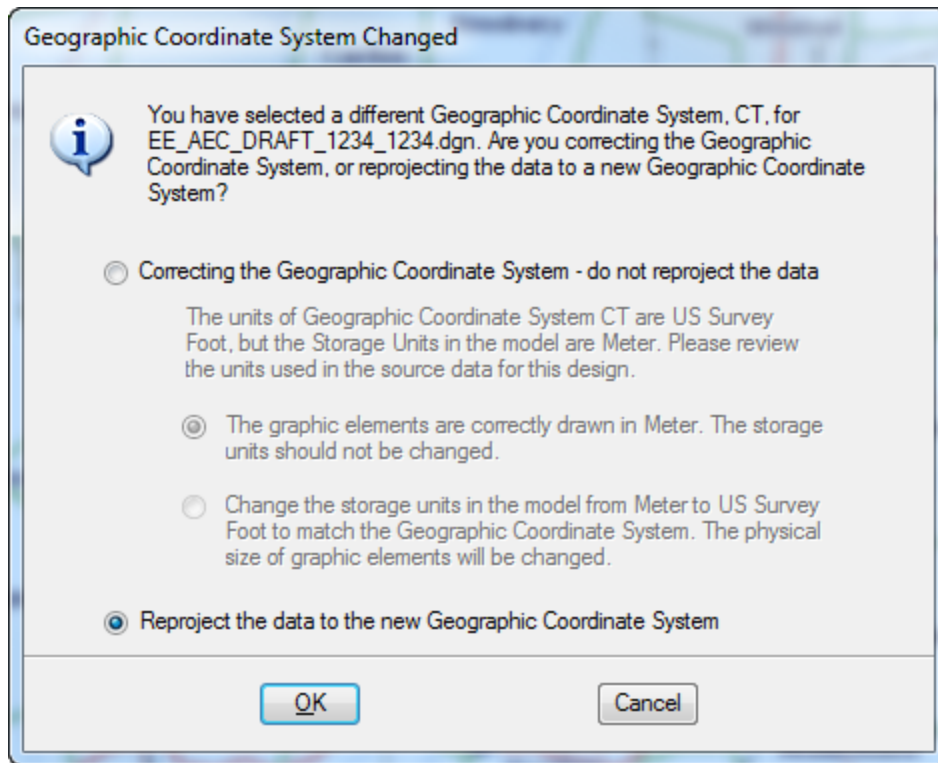

Figure 4-3 MicroStation Geographic Coordinate System Changed Dialog Box

4.3 Vertical Re-projection

Check the correct NAVD is being used. Select **CTDOT Utilities > Earth Exploration > Geographic Coordinate System Details**. Change the Vertical Datum to the required NAVD and select **OK**.
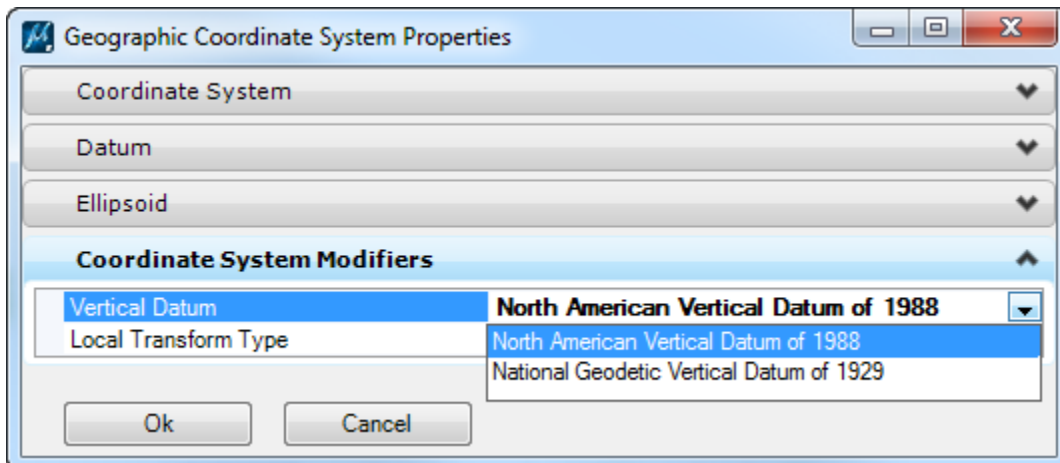

Figure 4-4 MicroStation Geographic Coordinate System Properties

4.4   Renaming Model

1. On the Geographic Coordinate System Changed dialog box select **Reproject the Data to the new Geographic Coordinate System** and select **OK**.

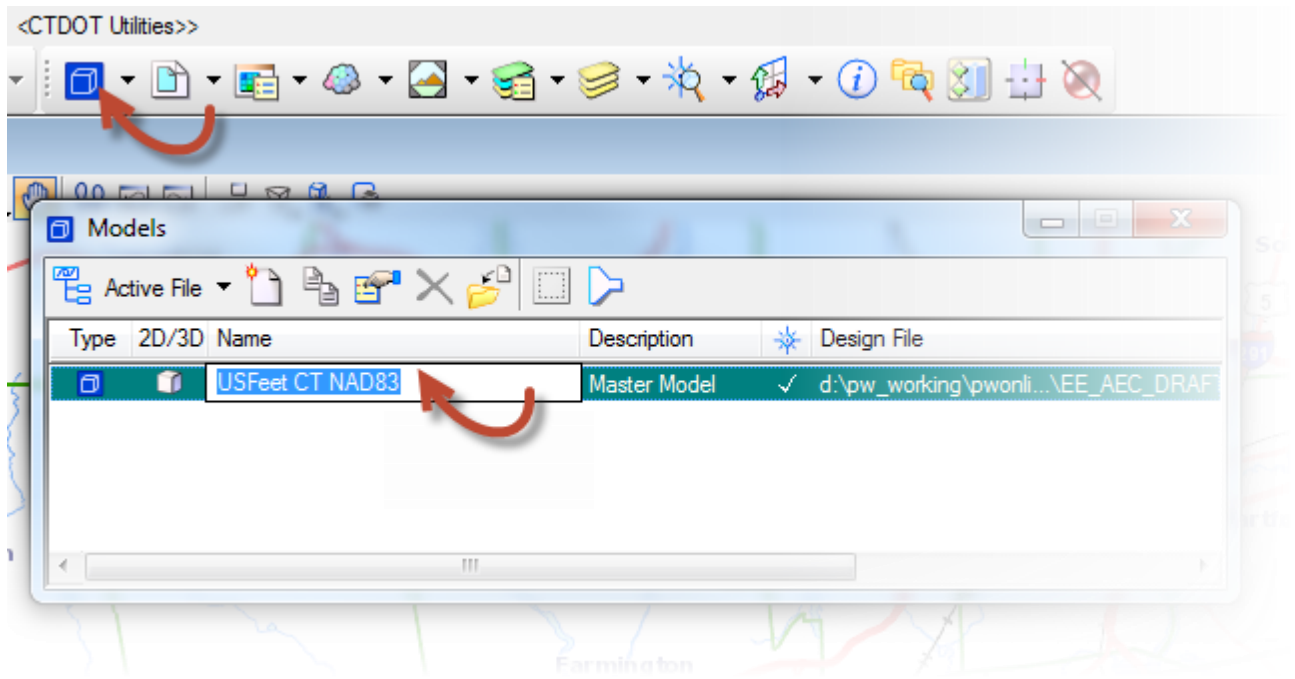2. Update the name of your model in the Models Dialog box

Figure 4-5 Edit Model name – MicroStation Models Dialog Box

3. If you need to use Aerial tools again you will need to set the coordinate system back to NAD 83 by selecting HARN (HPGN) Connecticut State Plane Zone, US Foot.

As stated in the introduction it is imperative that you check and make sure the following minimum software versions are loaded on your machine. The point cloud will not reproject if you have older versions of MicroStation.

Section 5 Using Point Clouds to Create Surface Data

There are numerous tools available in MicroStation and OpenRoads to create surface data from Point Clouds.
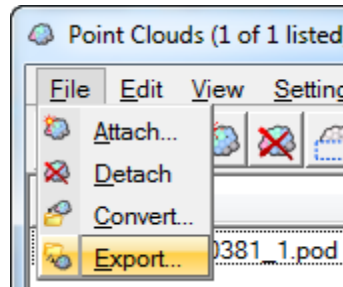
Point Cloud → ASCII → DTM

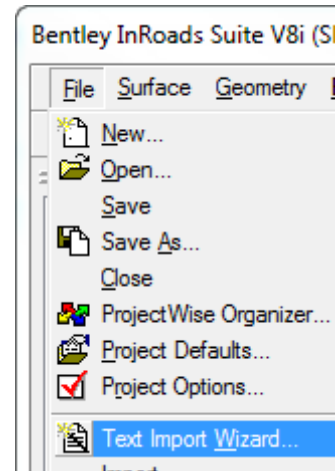**Figure 5-1 Point Clouds Export Command**

Figure 5-2 InRoads Text Import Wizard

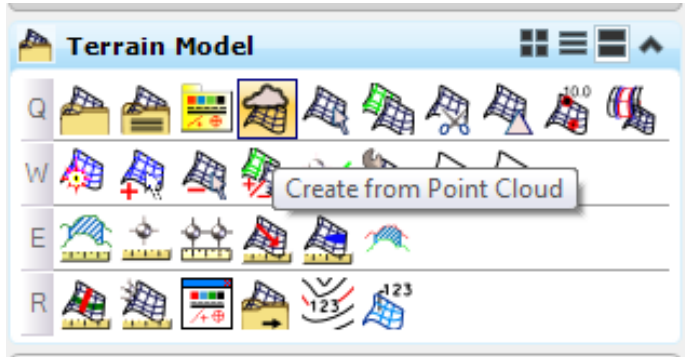## Point Cloud → OpenRoads Terrain → DTM

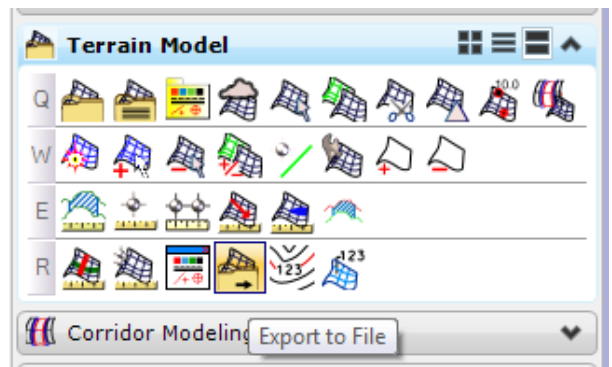**Figure 5-3 OpenRoads Terrain Create from Point Cloud Tool**

Figure 5-4 OpenRoads Export Terrain Model to File Tool

5.1 ASCII to DTM

5.1.1 Export Point Clouds to ASCII

At this point you will need to have the MicroStation file opened that contains the point cloud and datum you would like to work in.

1. Open the Point Clouds Tool Box. Select **CTDOT Utilities > Aerial Tools > Point Cloud Tools**.

2. Verify that all the needed point cloud POD files are turned on and selected.

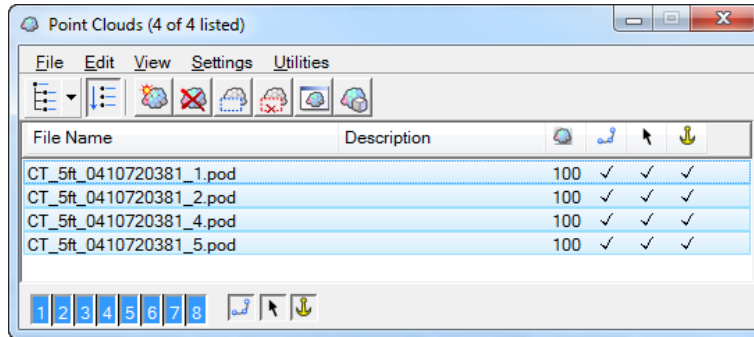3. If you have not done so already, use the Point Clouds clip command to clip the needed area.

Figure 5-5 MicroStation Point Clouds Dialog Box

4. On the Point Clouds dialog box select **File > Export**. Change the format to ASCII (*.xyz) and Region Filter to **Clip** (if you already have a clipped combined POD File from Section 3.3 you can leave this setting at **All**) and select **OK**.
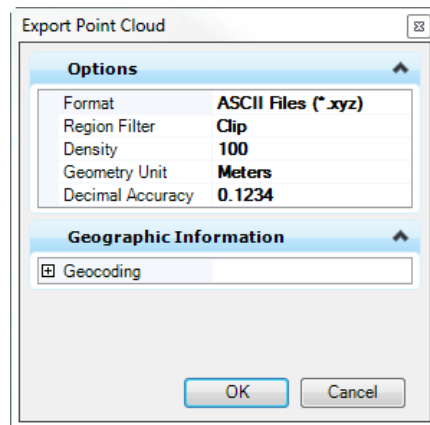

Figure 5-6 MicroStation Export Point Cloud Dialog Box

5. If you want to save the ASCII file in ProjectWise select **No Wizard** and **OK**. Select the correct folder path, edit the Name, Description and File name fields. Click **Save**.

6. If you want to save the file outside of ProjectWise click **Cancel** on the Select a Wizard Dialog box. Browse to the location you would like to store your file, for example, in a project on the X drive. Select the correct folder path and name the file. Click **Save**.

5.1.2 Create a DTM from ASCII

1. Go to Section 6 (close MicroStation, check in and export the needed files). Open MicroStation and InRoads through Accounting on the network and make sure the correct Configuration is active in your Project Defaults. If you do not see this you have not set up your Network InRoads project correctly. Go back to the CTDOT InRoads V8i Guide and complete section 1.
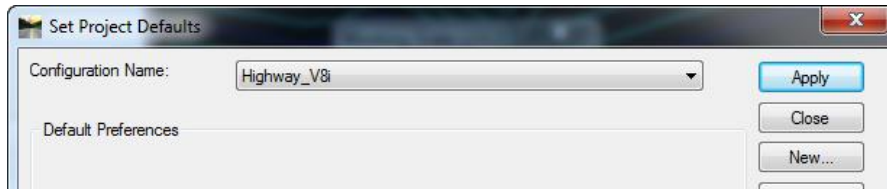http://www.ct.gov/dot/lib/dot/documents/aec/cad_selectseries/ctdot_ir_ss2_desgn_guide.pdf

Figure 5-7 InRoads Project Defaults Dialog Box

2. To create a new surface use the Text Import Wizard to Import the ASCII file. Select **File > Text Import Wizard**.

3. The Data Type should be set to Surface. In the File Name field browse to the location of the ASCII file. On the Open dialog box change Application or extension to **All** and click **OK**. Click **OK** on the Text Import Wizard dialog Box.
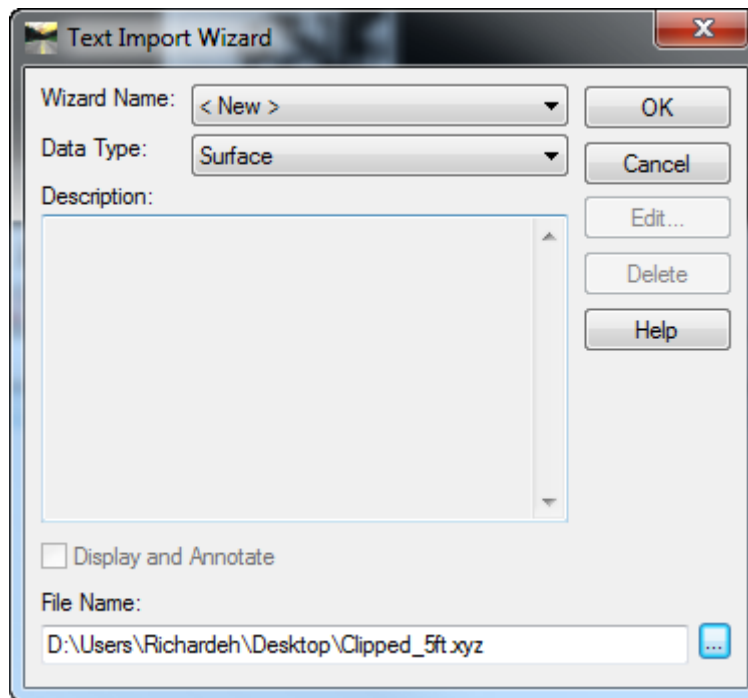

Figure 5-8 InRoads Text Import Wizard Dialog Box

4. Click **Next** through the steps of the Wizard. On Step 4 set up the column definition, column 1 = **Easting**, column 2 = **Northing**, column 3 = **Elevation** and select the **Finish Button**.
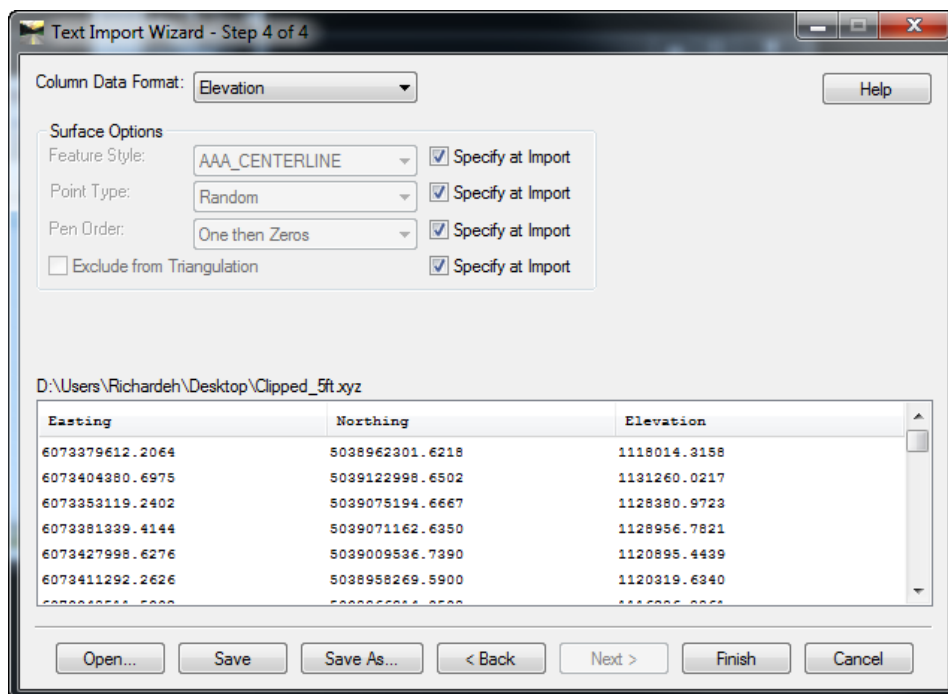

Figure 5-9 InRoads Text Import Wizard Dialog Box

5. In the Surface Options dialog box select a Seed Name and select the needed Feature Style, **LIDAR5 or LIDAR20**. If these names do not exist select **APOINT**. Select **OK**.
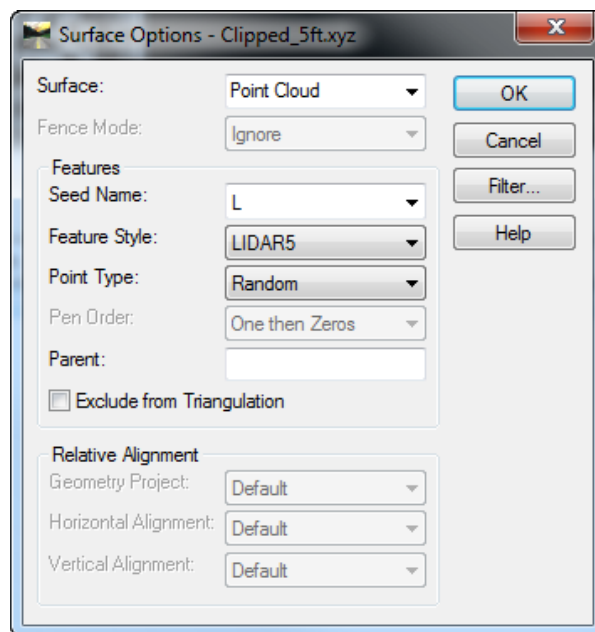

Figure 5-10 InRoads Surface Options

6. Select **Surface > Triangulate Surface**. Select the new surface and **Apply**.

7. To verify the location of the surface select **Surface > View Surface > Perimeter**. Select the new surface and **Apply**.

5.2 Create a Terrain from Point Clouds

1. On the MicroStation Task menu select **Civil Tools > Terrain Model** and select the **Create from Point Cloud** Icon.
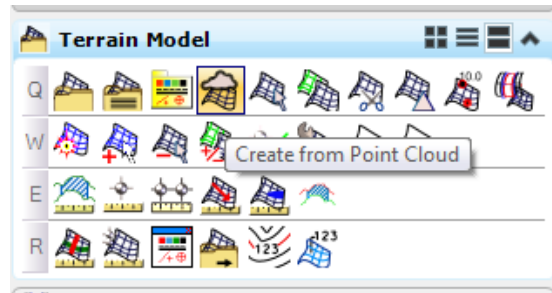

Figure 5-11 OpenRoads Terrain Create from Point Cloud Tool

2. On the Create Terrain From Point Cloud dialog box select the following:

   Filter: None
   Feature Definition: EX_TERR_Triangles
   Edge Method: No Removal

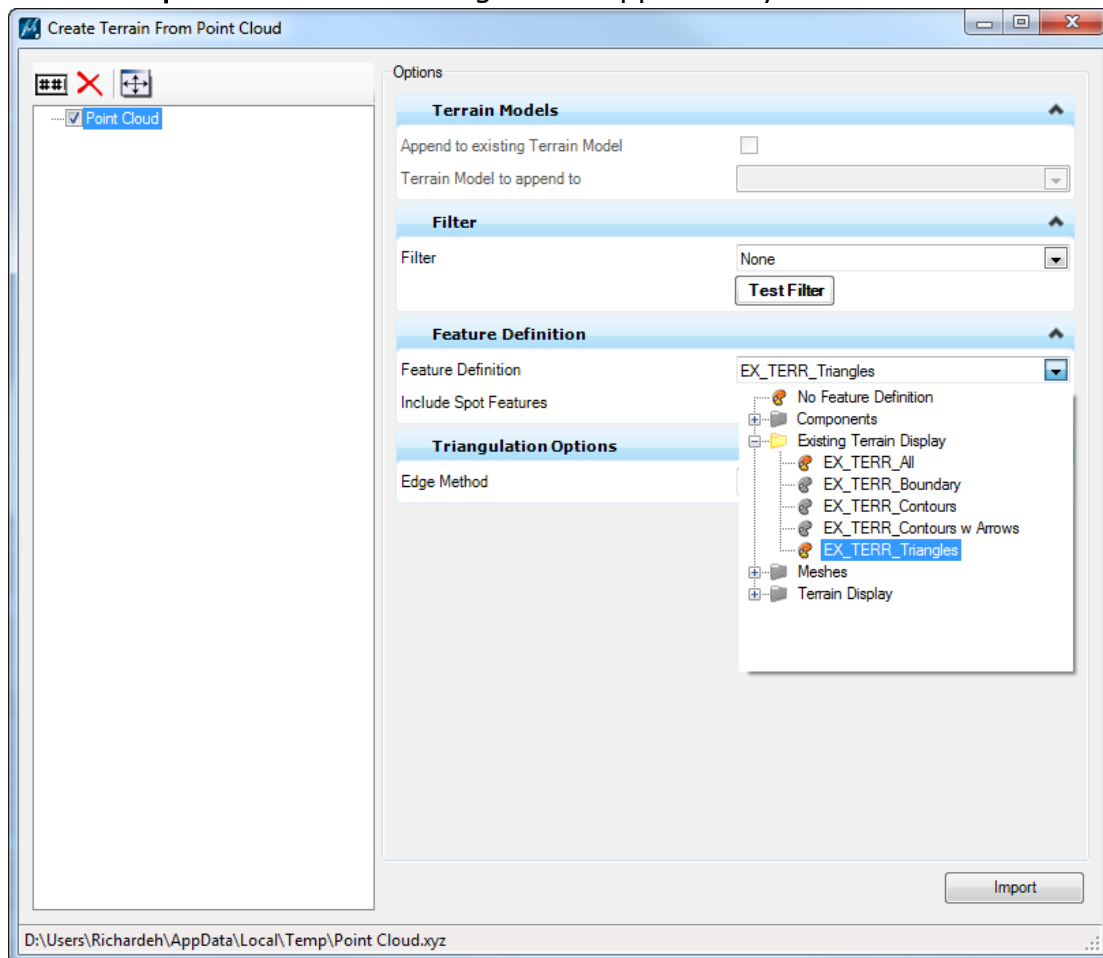3. Click on the **Import** Button and triangles will appear on your screen.

Figure 5-12 OpenRoads Dialog Box Create Terrain from Point Cloud

5.3 Create a DTM from an OpenRoads Terrain

1. On the MicroStation Task menu select **Civil Tools > Terrain Model** and select the **Export to File** Icon.
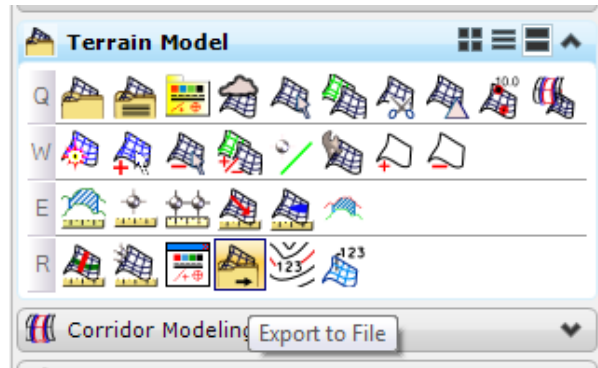

Figure 5-13 OpenRoads Export Terrain Model to File Tool

2. Select the correct Terrain and the export format Roads DTM (.dtm).
3. Save to ProjectWise or click cancel on select a wizard to save and external location.
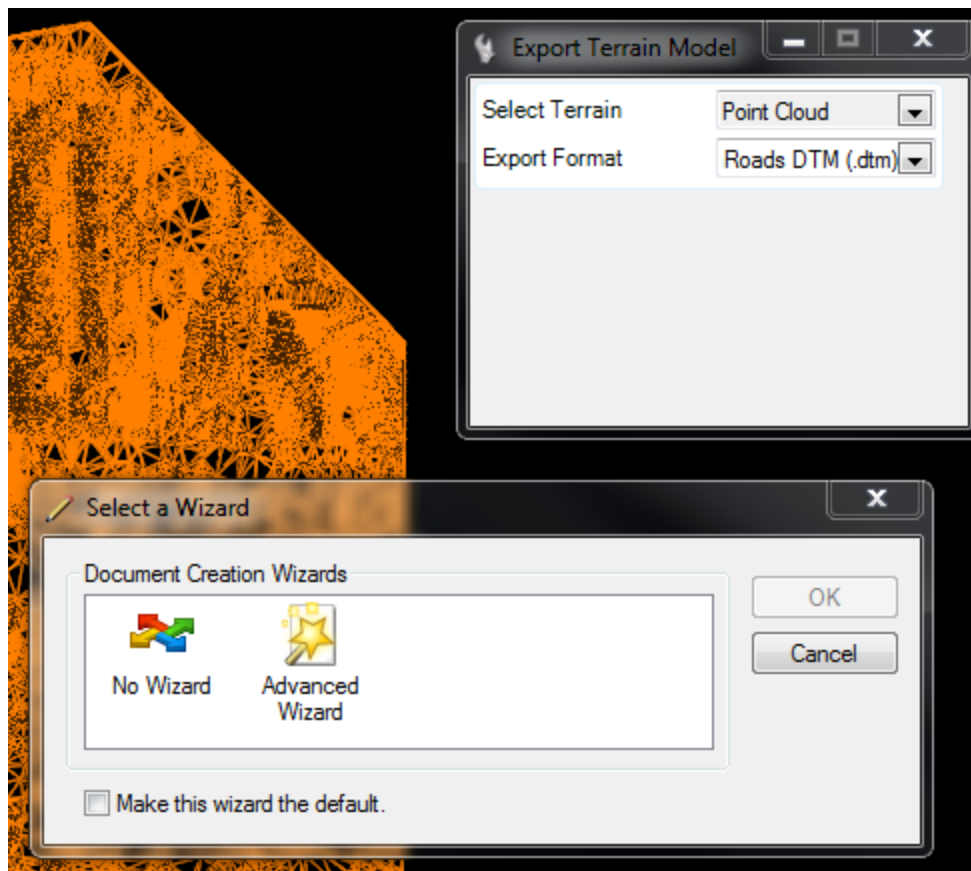

Figure 5-14 OpenRoads Export Terrain Model to File Dialog Box

Section 6   Finishing Up

6.1   Check Files Into ProjectWise

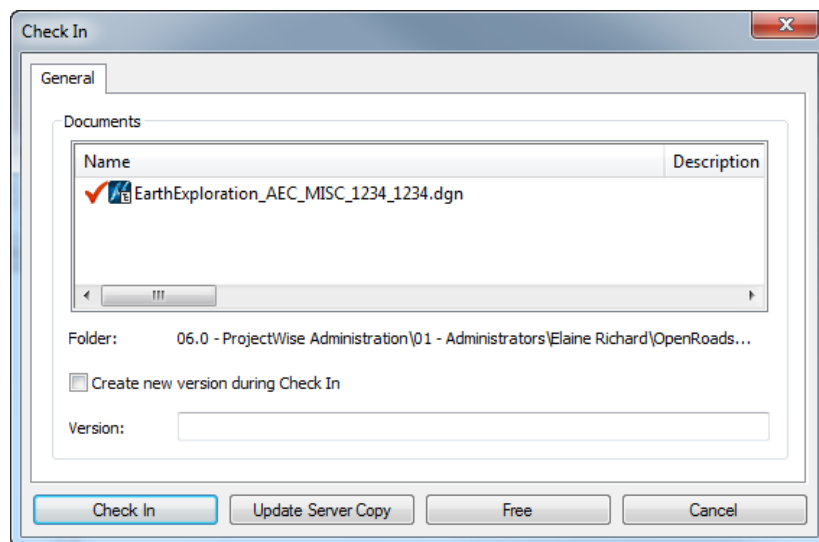1. To close your MicroStation select **File > Exit**. Click **Check In**.

2. On the Local Document Organizer right click on the all files you would like the check in and click the **Check In Leave Copy** button. Click on the red X to close the dialog box.
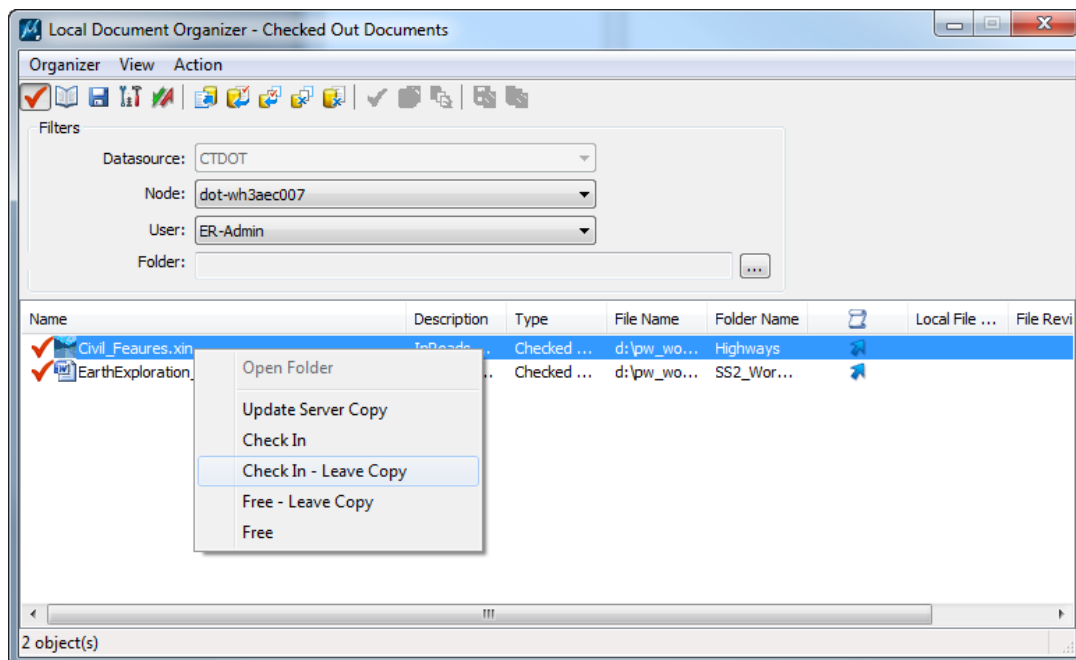

Figure 6-2 ProjectWise Local Document Organizer

6.2   Export Files to Network

1. In ProjectWise Explorer right click on the files that you would like to export and select **Export**.

2. On the Welcome Dialog box make sure **Send to Folder** is toggles on and click the **Next** button.

3. On the Define export settings dialog box click **Browse** and select the needed external location. Select **OK** on the Browse to Folder dialog box is selected and click **Next**. Click the **Finish** button. This will export the MicroStation file along with all the POD (point clouds) files, rasters and reference files that are attached. Repeat for any other files such as any DTM you would like exported.
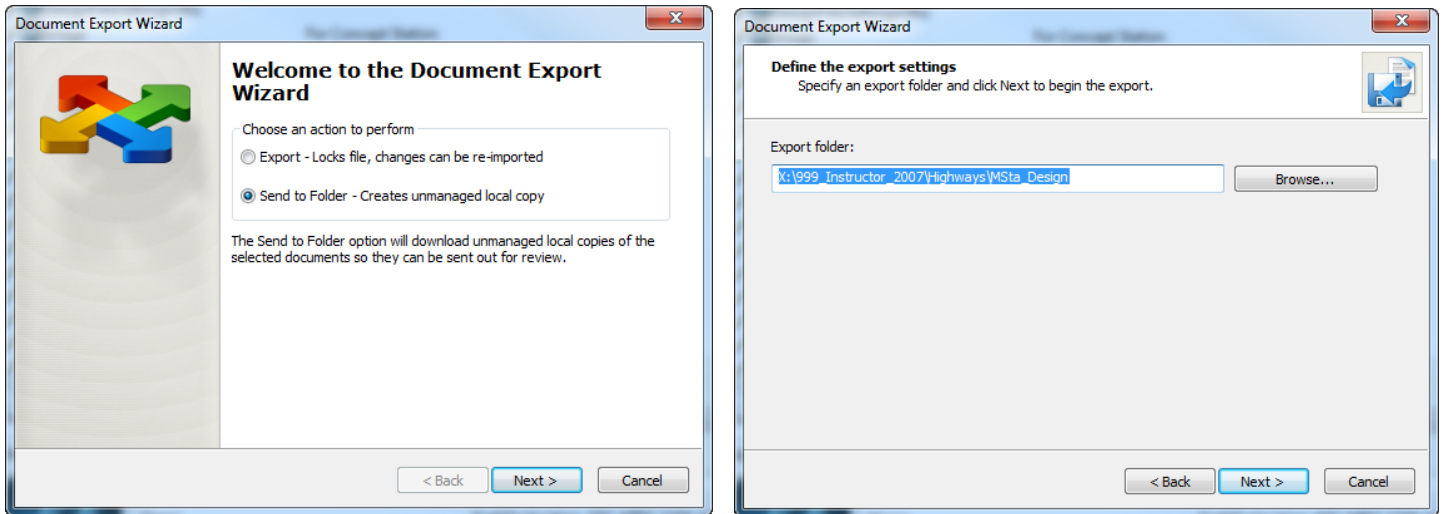

Figure 6-3 ProjectWise Document Export Wizard

4. **DO NOT ATTEMPT TO OPEN THE EXPORTED PROJECTWISE DGN FILE THROUGH ACCOUNTING.** Access MicroStation through Accounting and open an existing native network DGN file or create a file from the W drive seed file **W:\Workspace\Standards\ seed\ CT_Design_3D_V8i.dgn**. Using nested attachments reference in the exported ProjectWise DGN file and set the scale 1 to 1.

6.3 Tips Displaying DTM Contours

Displaying the graphic contours of large DTM's can bog your computer down and often lock up a DGN file. You can help this by limiting the amount of text that is displayed for the elevations.

1. On the InRoads Dialog box select **Surface > View Surface > Contours**.

2. Select the Preferences button, select **Survey** and click **Save As**. Give your new Preference a name and Click **OK**. Click **Load** and **Close**.
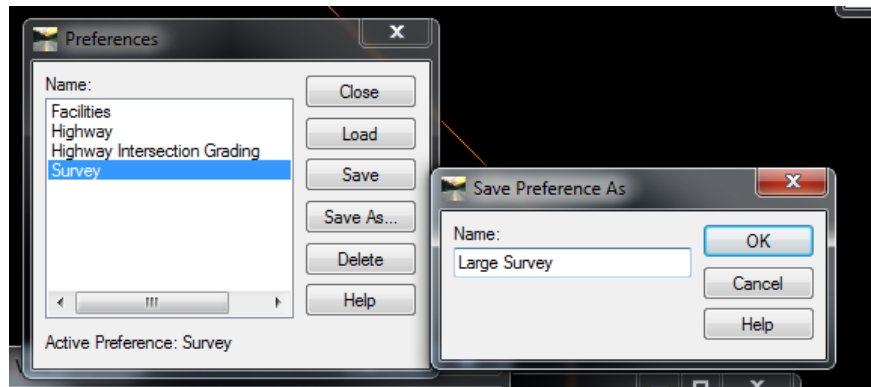

Figure 6-4 InRoads Preferences Dialog Box, Save As command

3. If you would like to see less labeling select the Labels tab and increase the spacing. This example was changed from 10 to 100.
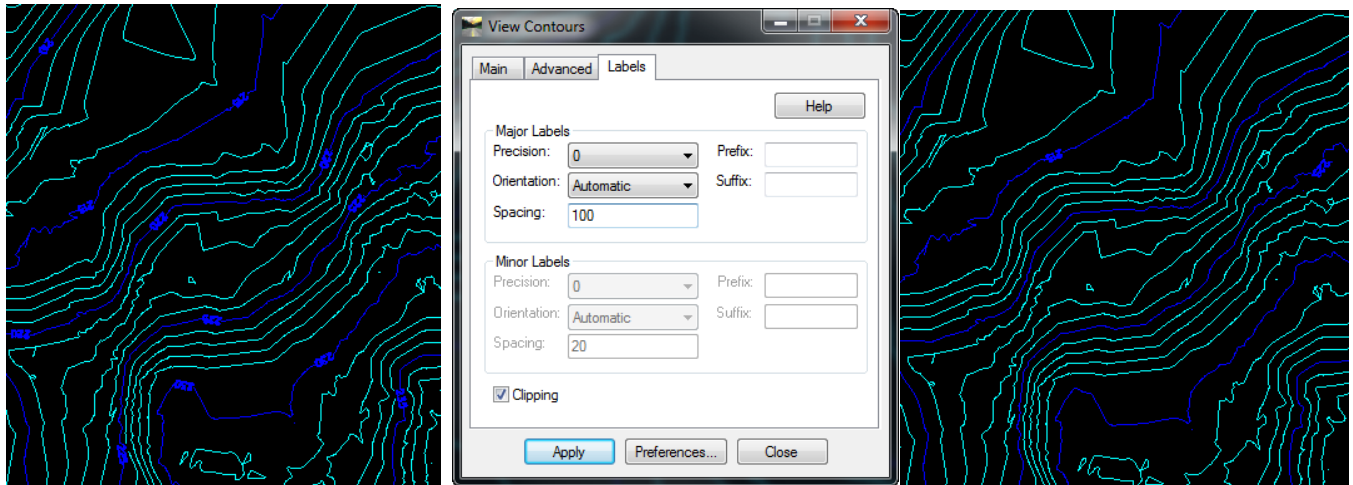

Figure 6-5 InRoads View Contours Dialog Box, Change Label Spacing

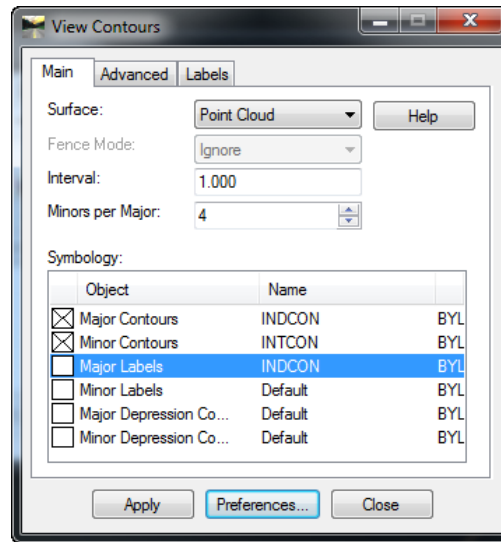3. You could simply turn off Labeling all together by unmarking the Major Labels box on the in View Contours.

Figure 6-6 InRoads View Contours Dialog, Disable Labeling

Section 7   **Glossary**

Geographically Re-projected

Survey is usually delivered in the Connecticut State Plane coordinate system NAD83 horizontal datum but in some instances it may be in NAD27. MicroStation now delivers tools that will make it possible to accurately project data in NAD83 line up will data from NAD27 and vice versa.

LiDAR

LiDAR means Light Detection And Ranging, it acquires data for thousands of points over the Earth's surface within a fraction of a second. LiDAR is the Remote Sensing technology that can find the range and other information about a particular distant object by the means of measuring the properties of scattered lights. The LiDAR sensors emit laser pulses in a scanning array, the information about the objects are determined from the time interval of these LiDAR (Light Detection And Ranging) pulses. The time delay of these transmitted pulses and detected reflected signals are taken as a distance of an object or surface.

MicroStation Point Cloud

A point cloud is a data file which can include a large number of points on the surface of an object. A point cloud is a set of vertices in a 3D coordinate system and these vertices are defined the by X, Y and Z coordinates. All of our LiDAR data has been converted to POD (Points Database) the point cloud file format used by MicroStation. The POD files use a point cloud engine which allows you to work with huge point clouds with quick speed and great performance compared to importing separate points into MicroStation.